



11-1978

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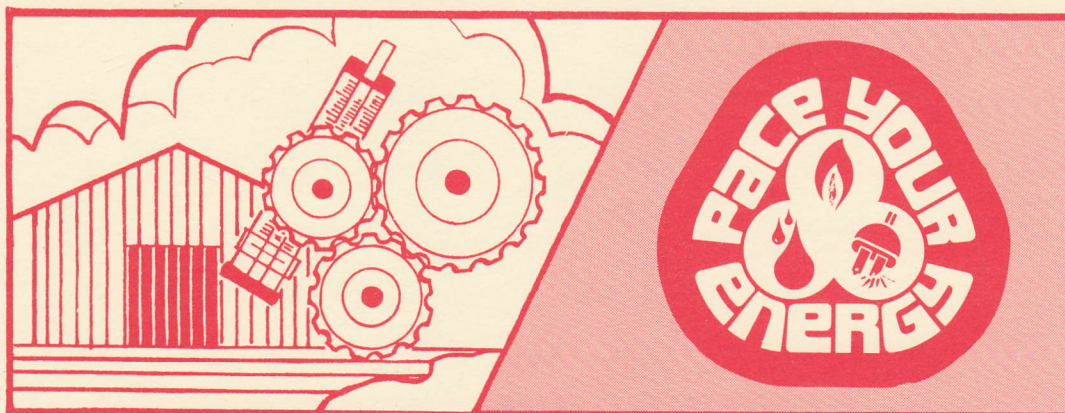
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ENERGY IN AGRICULTURE

GRASSLAND RENOVATION - CONSERVES SOIL AND ENERGY AND INCREASES RETURNS FROM GRASS FIELDS

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ENERGY

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Introduction

Fifty-four percent (1.2 billion acres) of land area in the 48 continental United States consists of grasslands, shrublands and open forests (1). For the most part, there is no alternative use of these land resources in production of food for man other than by way of ruminant animals. Sixty-nine percent (835 million acres) of these land resources is being utilized by grazing animals (1) and forms the basis for a livestock industry which represents 43% of all agricultural receipts in the United States (2).

Practically all of the beef animals are conceived and born on these grass fields (pasture and range), and experience their first few months of life there. When they reach weights of 400 to 700 pounds some of the animals find their way into feedlots. The majority of the beef brood cows spend their entire productive lives on these grass fields.

Grass plants must have nitrogen to grow, and the quantity of dry matter is proportional to the quantity of nitrogen available to the plants (3). Nitrogen has to be supplied from some external source because grass plants soon deplete nitrogen in the soil. Nitrogen fertilizer is one source of the nitrogen needed to maintain the productivity of grass fields. Each pound of nitrogen in commercial fertilizer represents an expenditure of 33,300 Btu of energy, primarily fossil fuel used to produce and process the fertilizer (4). For reasonable production, grasses require approximately 150 pounds of nitrogen per acre each year, an energy expenditure of about 5 million Btu per acre.

Legume plants use energy from the sun to supply nitrogen-fixing bacteria which live on the plant roots. Properly managed legume stands can fix up to 300 pounds of nitrogen per acre each year (3). When legume plants are grown in existing grass fields, they fix enough nitrogen for themselves and for the grass plants (5). Grass-legume mixtures also significantly improve feed quality as compared with grass alone (6).

Grassland Renovation

Grassland renovation is the improvement of pasture and hay fields by partial destruction of sod, plus liming, fertilizing and seeding as may be required to establish or re-establish desirable forage plants without an intervening crop (3). This improvement has been primarily through the

seeding of legumes into grass sods. A new renovation procedure, which involved the tilling and seeding of legumes in a very narrow band of soil with little or no destruction of the existing grass stand, was conceived as a method of improving the quantity and quality of feed for livestock from grass fields without destroying the grass and without any loss of production while the legumes are being established (7).

Grassland Renovation Conserves Soil

A grass cover, especially one consisting of those grasses which are sod forming, is an excellent deterrent to soil erosion by water or wind. The new renovation technology which has been developed to interseed legumes into grass sods with a minimum disturbance of the sod (8, 9) allows the soil erosion resistance characteristic of the sod to be retained while introducing the legumes into the stand. This technology can be applied on steep, easily eroded fields which should not be tilled or renovated in a conventional manner.

The grassland renovation seeder which has been developed (Fig. 1) interseeds legumes into grass fields in one trip over the field (9, 10). This seeder tills a furrow 1/2 to 3/4 inch wide and 3/4 inch deep and places the legume seed in this tilled furrow. The furrows are spaced 8 inches



Figure 1.—The grassland renovation seeder (John Deere, 1500 Powr-Till Seeder) which has been developed to interseed legumes into grass fields.

apart. The grassland renovation seeder disturbs less than 10 percent of the field surface and does not present an erosion hazard, even on very steep fields which contain easily eroded soils if the machine is operated across the hillside.

Grassland Renovation Conserves Energy

The principal energy input into the production of feed from unrenovated grass fields is nitrogen fertilizer. Nitrogen fertilizer should be applied to such fields at the time during the production cycle when the grass will promptly utilize it to produce high-quality feed. Soil moisture needs to be adequate to transfer the nitrogen to the plant roots. To meet these requirements cool-season grasses should receive nitrogen fertilizer in late February or early March and again in late July or early August (11).

The grassland renovation seeder was used to plant red clover and alfalfa into fescue in experiments at Lexington, Kentucky (5). Plots that were seeded with red clover at a rate of 6 pounds of seed per acre were as high yielding during the establishment year as fescue receiving 100 pounds of nitrogen per acre. During the year after establishment, the renovated red clover-fescue mixture was as high yielding as fescue receiving 200 pounds of nitrogen per acre. The red clover-fescue vegetation was analyzed for N-concentration and contained 147 pounds more N than the fescue check. It is clear that the red clover added 147 pounds of nitrogen per acre to the forage obtained from the grass-legume system.

These data substantiate one significant energy-conserving feature of grassland renovation. Red clover seed represent an energy investment of approximately 7,100 Btu per pound (12); since most red clover behaves as a biennial, the annual energy investment for 6 pounds per acre is 21,400 Btu per acre per year. Nitrogen most frequently is assumed to have an energy investment of 33,300 Btu per pound (4). During the establishment year for renovated fescue-red clover, 100 pounds of nitrogen are required to obtain the same dry matter yield from unrenovated fescue. The energy investment for the unrenovated field is 3,333,000 Btu per acre, which is 3,312,000 Btu per acre greater than the renovated field, excluding energy investment associated with machinery operation for renovation. During the second year, 200 pounds of nitrogen are required and the energy investment is 6,666,000 Btu per acre, which is 6,645,000 Btu per acre greater than when renovating.

The development of a grassland renovation seeder (7, 8, 9, 10) enhances the capability of the farmer to renovate grassland, and further enhances the opportunity for energy conservation as compared with previous methods of grassland renovation. The grassland renovation seeder (Fig. 1) also enables the farmer to use grassland renovation on grass

fields where conventional tillage and seeding machines cannot be used.

Experiments were conducted at each of 24 different locations in Kentucky during 1974 and 1975 to compare the energy required by the grassland renovation seeder with that required by conventional tillage and seeding implements. One diesel tractor was used to power all of the implements used in these experiments, and the tractor was operated in the same transmission gear and at its rated engine speed in all tests. The ground speed was approximately 4 mph. The fuel consumed by the tractor was measured for each treatment block in each experiment, and analysis of these data revealed that grassland renovation with conventional tillage and seeding implements required significantly more fuel per acre renovated than was required with the grassland renovation seeder. The mean values of these data are presented in Table 1. The grassland renovation seeder requires 139,000 Btu of energy per acre as compared with 663,000 Btu of energy when conventional implements are used to renovate grass fields.

Table 1.—Fuel Consumption: Gallons per Acre*

Conventional Tillage and Seeding Implements**	Grassland Renovation Seeder
4.95	1.04
Ratio: $\frac{\text{Conventional}}{\text{Renovation Seeder}} = 4.76:1$	

*134,000 Btu per gallon of diesel fuel.

**Conventional tillage consisted of three times over with an offset disk harrow, one time over with a grain drill, and one time over with a cultipacker.

The renovation of fescue by planting 6 pounds of red clover seed per acre plus the fuel consumed in planting the seed with a renovation seeder represents a total energy investment of 91,300 Btu per acre each year. If one includes the energy for field spreading of fertilizer (12), nitrogen fertilization of grass fields to obtain dry matter yields comparable to renovation requires an average energy investment of 5,040,000 Btu per acre each year. The energy conserved by grassland renovation with the developed grassland renovator as compared with nitrogen fertilization of fescue grass fields is therefore about 4,960,000 Btu per acre each year. A summary of these energy inputs is presented in Table 2. Grassland renovation, in fact, substitutes a renewable energy source for a nonrenewable source.

Table 2.—A Summary of the Energy Inputs for Improving Production from Grass Fields (millions of Btus per acre)

Energy Input	Method of Improving Production		
	Nitrogen Fertilizer	Renovation	
		Grassland Renovator	Conventional Implements
Seed	-	0.020	0.020
Nitrogen Fert.	5.00	-	-
Mach. Operation	0.04	0.071	0.330
Total	5.04	0.091	0.350

Grassland Renovation Increases Returns from Grass Fields

Much of the feed produced on grass fields in the U. S. is utilized by grazing beef animals (1). The quantity of dry matter produced on grass fields can be improved by proper fertilization with lime, phosphorus, potassium and, especially, nitrogen (5, 7). Grassland renovation to establish legumes in grass fields improves the quantity of feed without the use of nitrogen fertilizer (3, 5, 15). The feed produced with a legume-grass mixture is of higher quality than that produced by nitrogen fertilization of the grass (6, 15).

Lechtenburg, et al., conducted grazing experiments on fescue fields which were fertilized with 150 pounds of nitrogen per acre each year and on fescue fields which were renovated by seeding 1/2 pound of ladino and 5 pounds of red clover per acre into the fescue (6). Data from these experiments are summarized and presented in Table 3.

Table 3.—Performance of Cows and Calves Grazing Tall Fescue and Tall Fescue-Legume Pastures During a 3-Year Period (6)

	Tall Fescue	Tall Fescue-Legume
<u>Calf Performance</u>		
Average daily gain (lb)	1.28	1.82
Weaning weight (lb)*	351	436
<u>Cow Performance</u>		
Average daily gain (lb)		
Lactating cows	0.17	0.73
Non-Lactating cows	0.60	1.12
Conception (%)	72	92

*205-day adjusted weight.

The superior quality of the feed produced by renovating to introduce clover into the fescue is evidenced by significantly better performance of both cows and calves. Calves made significantly higher average daily gains and achieved significantly higher weaning weights on renovated clover-fescue than on fescue which was fertilized with 150 pounds of nitrogen per acre each year. The superior performance of lactating cows when grazing clover-fescue is extremely important; especially significant is the higher conception rate of these cows. The legume:fescue ratio averages approximately 30:70 on a dry weight basis in the renovated pastures (6).

The data presented in Table 3 can be used to examine the increased returns from grass fields when grassland renovation is compared with the use of nitrogen fertilization. A 100-cow unit can be analyzed on the basis of these data to show the relative magnitude of the increased returns.

If 100 cows are grazing a renovated clover-fescue mixture, 92 of them will conceive and produce calves. Each of these calves will weigh 436 pounds when weaned. This represents a potential production of 40,112 pounds of beef each year from 100 brood cows.

If 100 cows are grazing a fescue field which has been fertilized with 150 pounds of nitrogen, 72 will conceive and produce calves. Each of these calves will weigh 351 pounds when they are weaned. This represents a potential production of 25,272 pounds of beef from 100 brood cows.

The relative magnitude of the increased returns from grass fields by using grassland renovation as compared with nitrogen fertilization could be on the order of 40,112 to 25,272 or 1.59:1. The increased returns using grassland renovation can be accomplished with significantly lower energy input than is required with nitrogen fertilization. As was shown earlier, the energy investment of 6 pounds of red clover seed plus the tractor fuel to plant the seed using the developed grassland renovator is 91,300 Btu per acre

each year and the energy investment to supply 150 pounds of nitrogen per acre each year is 5,040,000 Btu. This ratio is 1:55.

Summary

A grassland renovation seeder has been developed to interseed legumes into existing grass fields. This seeder disturbs less than 10 percent of the grass sod. Most of the sod remains to prevent soil erosion, even on steep slopes.

Grass fields which were renovated with a grassland renovation seeder by planting 6 pounds of red clover seed per acre required an energy investment of 91,300 Btu per acre each year for seed and tractor fuel to operate the grassland renovation seeder. Nitrogen fertilization of grass fields with 150 pounds of nitrogen per acre each year required an energy investment of 5,040,000 Btu per acre each year. Nitrogen fertilization of grass fields requires an energy input of 55 Btu as compared with each Btu of energy input when the new grassland renovation unit is used instead of nitrogen.

Potential returns in the form of beef produced on the grass fields per 100 brood cows was increased from 25,272 pounds with nitrogen fertilization to 40,112 pounds with grassland renovation to obtain a clover grass mixture. Grassland renovation yielded 1.59 pounds of beef for each pound with nitrogen fertilization.

For more information about the renovation seeder and how it can be used refer to University of Kentucky Cooperative Extension publications ID-32 and ID-33, available from your county Extension office.

REFERENCES

1. "Opportunities to increase red meat production from ranges of the United States." USDA, June, 1974.
2. Reid, J. T. "A Re-Evaluation of the Importance of Forages." Proceedings - No Tillage Forage Symposium, Ohio State University, Columbus, Ohio, October, 1975.
3. Evans, J. K., G. Lacefield, T. H. Taylor, W. C. Templeton, Jr. and E. M. Smith. "Renovating Grass Fields." Coop. Ext. Service-AGR-26, University of Kentucky - College of Agriculture.
4. Pimental, David, L. E. Herd, A. C. Bellotti, M. J. Forster, I. N. Oba, O. D. Sholes and R. J. Whitman. "Food Production and the Energy Crisis." Science, Vol. 182, November, 1973.
5. Taylor, T. H. "Establishing Legumes in Tall Fescue Sod." Paper presented at the Southern Beef Conference, Greenville, S.C., December, 1975.
6. Lechtenberg, V. L., W. H. Smith, D. C. Petritz, and K. G. Hawkins. Performance of Cows and Calves Grazing Orchardgrass, Tall Fescue, and Tall Fescue-Legume Pastures." Beef-Forage Research Day, November 12, 1975.
7. Taylor, T. H., W. C. Templeton, Jr., and E. M. Smith. "History and Concept of Grassland Renovation in Kentucky." Proc. 33rd Southern Pasture and Forage Improvement Conference, Mississippi State University, April, 1976.
8. Taylor, T. H., E. M. Smith, and W. C. Templeton, Jr. "Use of Minimum Tillage and Herbicide for Establishing Legumes in Kentucky Bluegrass (*Poa pratensis* L.) Swards." Agronomy Journal, Vol. 61, Sept.-Oct., 1969.
9. Smith, E. M., T. H. Taylor, J. H. Casada, and W. C. Templeton, Jr. "Experimental Grassland Renovator." Agronomy Journal, Vol. 65, May-June, 1973.
10. Bucher, D. H., T. E. Hitzhusen, and D. T. Sorlie. "John Deere 1500 Powr-Till Seeder." Paper No. 75-1591, Winter Meeting ASAE, Chicago, Illinois, December, 1975.
11. Templeton, W. C., Jr., T. H. Taylor, and J. W. Wyles. "Harmonizing Feed and Cattle Production." Proceedings - 3rd Kentucky Grassland Conference, Lexington, Kentucky, February, 1972.
12. Walker, J. N. "Energy Usage in Crop Systems." Proceedings of Conference - Workshop on Energy in Agriculture, Atlanta, Georgia, October, 1975.
13. Steinhart, J. S. and C. E. Steinhart. "Energy Use in the U.S. Food System." Science, Vol. 134, April, 1974.
14. Templeton, W. C., Jr. "1975 is Year of the Legume." Forage and Grassland Progress, Vol. XVI, American Forage and Grassland Council, Fall, 1975.

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Issued in furtherance of Cooperative Extension work, Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture. Charles E. Barnhart, Director of Cooperative Extension Service, University of Kentucky College of Agriculture, Lexington, and Kentucky State University, Frankfort.